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| **Lesson Title: Order of Operations** |
| **5th grade Math** |
| **Introduction:** The students will work on understanding the importance of order of operations and applying them to basic algebraic problems. |
| **Lesson Length**: 2 days |
| **Materials:**  2 sets of each (3 different colored papers) Real Life Task Cards  1-2-3 Order Me Please, Out of Order, and Make the Number worksheets (1 per student)  Interactive Notebook  ELMO  TI-15 calculator |
| **Lesson Overview:** The lesson applies/extends the order of operations with practice in a game context. Together with property of substitution, the order of operations is used to evaluate a variable expression.  Online applets (NCTM Illuminations) and technology (TI-73) are employed to deepen understanding about substitution and evaluation of expressions |
| **Tennessee Standards:**  **State Performance Indicators:**  SPI 0506.3.1 Evaluate algebraic expressions involving decimals and fractions using order of operations.  SPI SPI 0506.3.2 Evaluate multi-step numerical expressions involving fractions using order of operations.  SPI 0506.3.3 Find the unknown in single-step equations involving fractions and mixed numbers.  GLE 0506.3.1 Understand and use order of operations.  GLE 0506.3.2 Develop and apply the concept of variable.  GLE 0506.3.3 Understand and apply the substitution property. |
| **Lesson objective(s):**  **The students will see the importance of order of operations in math and in life.**  The students will also:   * correctly verbalize order of operations * apply order of operations when simplifying/evaluating expressions * use correct notation to write a numerical expression * substitute a value for a variable in an expression using grouping symbols appropriately to retain order of operations * use technology with appropriate notation to evaluate expressions   Training Discussion: “I Can…” Statements (expressions/equations) |
| **ENGAGEMENT**  **Show the video/song on Order of Operation –** [**http://www.schooltube.com/video/6eb807e5620d49bd5687/the-order-of-operations-songrap-to-the-tune-of-umbrella**](http://www.schooltube.com/video/6eb807e5620d49bd5687/the-order-of-operations-songrap-to-the-tune-of-umbrella)  Have the students write in their interactive notebook what they already know about Order of Operations   |  |  |  | | --- | --- | --- | | Ask students to arrange index cards, each of which contains one step of an everyday process for which order of steps is unique. | | | | Grocery Shopping | Build a house | Wrap a gift | | Drive to store  Park car in store parking lot  Exit car  Walk to store entrance  Get a cart to roll thru store  Fill cart with groceries  Roll cart to check out  Place cart items on counter  Pay for groceries  Put bags back into cart  Exit store  Walk cart to car  Put groceries in car  Get in car to go home | Get materials  Make foundation  Build floor  Make frame for walls  Add roof  Add windows and doors  Add electrical lines/water pipes  Insulate walls  Cover wall studs with drywall  Paint walls | Secure item for gift  Remove price tag  Place item in box  Cut paper to fit box size  Wrap paper around box  Fold paper to box shape  Tape folds of paper in place  Wrap ribbon around box  Tie ribbon in bow  Add card to top of box |  |  | | --- | |  | | **EXPLORATION**  Present one or more numerical/variable expressions including multiple operations and ask students to determine a number that they believe is the same as the given expression and to write that value on an index to be handed to the teacher  **Simplify 14 – 6 x 4 – 2 (20 ÷ 5 – 1) Evaluate 5ab2 – 4a/2 + b when a = 12 and b = 4**  Before you begin as a class to look at the values, **(HOT)** ask students to make observations (record their observations on the board) about each expression one at a time and to make comparisons between them. **(CQ)** Can they identify which is called a numerical expression and which is called a variable (algebraic) expression?  List class members’ values on the board. In case all the answers are correct, have a few cards ready with answers gained by incorrect order of operations so you can indicate the importance of all using the same “conventions” or order of operations. Ask volunteers to show how the value might be different depending upon which operation is performed first, second, third, etc.  **(CQ)** Conclude with the question: Which one is correct?  Students have some experience with order of operations. Ask students what order of operation rules they already know. Generate a list on the board.  Follow up by adding precision to directions similar to how the directions to ‘make a jelly sandwich’ steps in process were clarified. For instance, if a student says MDAS, clarify M is not before D but that are done in the order in which they occur when moving form left to right in the expression.)  As a whole class or in small groups begin to develop a **Graphic Organizer for Order of Operations** that they have already experienced (flow chart, linear array, outline).  **(CQ)** Ask: What about those expressions we have discussed is confusing to you? What do you see in this expression that isn’t covered by the rules we already know? Generate a list of issues not addressed by rules they already know (e.g. unknown operation symbols; grouping symbols; exponents; change in symbols to accommodate a variable changed to a numeral (substitution), etc.)  Big Idea: We need an order of operations that is consistent so we will know what value an expression has.  **(CQ)** Conceptual questions embedded throughout scripted lesson. | | **EXPLANATION**  **CQ)** Ask students to explain their understanding of terms: **evaluate, simplify**.  **(HOT)** Generalize common notions.  Revisit problems:  Simplify 14 – 6x4-2(20÷5-1)  Evaluate 5ab2 – 4a/2 + b when a = 12 and b = 4  Deal with identified issues: unknown operation symbols; grouping symbols; exponents; change in symbols to accommodate a variable changed to a numeral (substitution), etc.  **(HOT)** Are there some “implied instructions” as discovered when making the jelly sandwich to operations implied by mathematical notation (i.e. m/5 means m x 1/5 or m÷5; implied multiplication: 3n means 3 times n and the number in a position like 3 is called a **numerical coefficient**; (4)(5) means 4 x 5) and “conventions” (i.e. writing coefficients before variables in a term, writing variable factors in alphabetical order.)  **(HOT)**: Summarize: What can we change or add to our (student generated) ‘order of operations list’ to establish a comprehensive set of rules?  **(HOT)** Ask students for suggestions to refine order of operations **graphic**.  Apply caution when students say PEMDAS: identify and clarify issues inherent in the PEMDAS acronym for order of operations. Immediately use established order of operations to simplify the given expressions to one value.  **(HOT)** Develop understanding of the term **expression**. (Concept card, Math journal vocabulary page) Add new terms as identified in lesson to Word Wall and incorporate them into word wall activities. (Training Handouts)  **(OE)** Student partners together on 2-3 practice problems (from text or board) while teacher circulates. | | **ELABORATION**  Training Discussion: Agree or not? “Games/competition peak student interest.” Identify PROS/CONS.  **(HOTS)** These activities give students practice writing numerical expressions using math symbols. Students develop strategies.  **(OE) Order Please?** From TN DOE Gateway Training Manual, Phase I (Game board handout)  In this activity, teams collaborate as they compete to be the first to cover four numbers in a row on a game board. Students will create a numerical expression that equals one of the numbers on the game board using a set of numbers gained from rolling three number cubes. Teams must present their CORRECTLY written and simplified expression before they can use their teams’ marker to cover a number.  **(OE) Target Number: construct numerical expression to compute given value or one close to it.**  In this activity, students will have a target number and a set of numbers that they can use to try to hit (or get close to) the target number. Score on each round is the difference between target number and value of constructed expression. Lowest total score wins. (Game sheet with instructions handout.)  Notes to teacher: In both activities, choice and order of operations are student decisions. However, it is not as easy as it sounds! Quite often students will be able to verbalize what they will do with the set of numbers to get the target number but it takes some practice for them to be able to put the symbols together so that the expression, following the order of operations, actually equals the number they intend for it to equal. Be sure to work enough examples as a whole group before you let them play the game. If one person hits the target number very quickly, **(HOT)** ask if students can think of other ways to hit the same target with the same set of working numbers. As they give their ideas, let them verbalize the order of operations and describe the notation they will use. Keep working to get the expression to contain all required numbers and get close to the target number. Emphasize that the objective of this game is to get a low score!  **The following examples given in terms of the Target Numbers activity apply to both activities.**  **Address the issue of getting all numbers into an expression with this example**.  **Example:** Target number = 41 Working numbers {3,3,5,2,1}  One way to get the 41 is to number 6 and 7, multiply them, and subtract 1 appropriately written as  (3+3)(5+2)-1 = 41  Beginners may write 3+3=6 and 5+2 = 7 and 6x7=42 and 42-1 = 41 which is not **a numerical expression** containing all five working numbers. You will have to help them include all five numbers and operations into one expression.  **Address the issue of improper use of the = sign with this example**  **Example:** Target Number = 31 Working numbers {4,3,3,3,5}  A beginner may write 3+3=6x5=30+4=34-3=31. The operations used to put the number together are correct but **the use of the string of equals signs is not correct**. This statement actually says that 6=30=34=31. Remind students that we have a way to circumvent the MDAS order i.e. use of parentheses.) **(HOT)** Ask students for an improvement on plan shown in the example.  **Help students develop mathematical concepts as well as strategies as they construct expressions with this example.**  **Example:** Target number = 18 Working numbers {4,2,2,3,6}  It is possible to get the target 18 using only two of these numbers 3 x 6. One strategy is to figure out a way to make the rest of the numbers equal 1. **(HOT)** Ask students how that will help – if you multiply the expression that equals 1 by the existing value, the answer will not change, i.e. 1 x 18 = 18. (1 is called the **identity element for multiplication** because when you multiply a number by 1 you get a product **identical** to the number you multiplied it by.) Ask: How can we do this?  Another strategy is to figure out a way to make the rest of the numbers equal 0. **(HOT)** Ask students  how that will help – if you add the expression that equals 0 to the existing value, the answer will not change, i.e. 0 + 18 = 18. (0 is called the **identity** **element for addition** because when you add 0 to a number, you get a sum **identical** to the number you added it to.) Ask: How can we do this?  Vocabulary (see use in examples): numerical expression, variable (algebraic) expression, numerical coefficient, evaluate, simplify; meaning of mathematical symbols, equality and equal sign, identity element for addition/multiplication | | **EVALUATION**  **OE) denotes Opportunities for Evaluation embedded in exercises, games, and activities.**  Students can demonstrate correct application in traditional format in board work, homework, quiz, warm-up in succeeding class.  **Alternative Opportunities for Evaluation**  A. SNATCH: Practice with whiteboard/dry erase marker (provides immediate feedback.)  B. Centers: Students collaborate in pairs or small groups to complete one or more tasks at each center Select any of the following ideas or develop your own.   1. Task: Manual application of order of operations involving whole numbers 2. Task: Manual application of order of operations in problems involving fractions, decimals, or mixed numbers. 3. Task: Manual evaluation of variable expressions using substitution and order of operations. 4. Task: Using provided TI-73 or TI-84 calculators, check work from one of previous centers. Write about errors you discovered. 5. Task: Simplify expressions to decode answer to a riddle (see Algebra with Pizzazz) 6. Task: Hands-on evaluation of expression using set of algebra tiles. 7. Task: Generate a worksheet to be used with VersaTiles™ (ETA/Cuisenaire (Automatic check by creation of correct tile pattern) 8. Task: Computer (one or more) available for students to use applet in NCTM Illuminations (demonstrated in training) 9. Task: Correct and explain in writing error(s) you can find in the work shown. 10. Task: Use one of your names (first, middle, last) or some combination of your names so that you have at least 5 letters. Assign letter values (a=1, b=2, c=3, etc.) and use those values to create a numerical expression that will simplify to your age. (If you can’t get exactly your age, get close as close to it as you can.) 11. Task: Use the numerical expression you created in the previous center. Substitute the letters in place of the numbers in the numerical expression to get a variable expression that will simplify to your age (or to a number close to your age).   C. Individual evaluation  *Make the Number* (handout), *Out of Order* (handout), 1-2-3 *Order Me Please* (handout) | |